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TECHNICAL MEMORANDUM 95

TECHNICAL PROBLEMS OF COMMERCIAL FLYING.

By Edward P. Warner,
Professor of Aeronautics,
Massachusetts Institute of Technology.

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The war is to be credited with having fostered a great advance in aeronautics, but even there its effects on technical developments have not been a clear gain. The war led to an expansion of aircraft production facilities which was impossible to maintain under peace conditions, and the aircraft industry finds itself as a result saddled with enormous plants whose overhead eats up the whole gross revenue now obtainable.

In designing, too, the return to normal conditions has been difficult. The engineer who concentrated his attention for four years on military requirements and service aircraft finds it difficult to get back to a normal state of mind and to interpret the requirements of commercial design without having the needs of the army always before him. Only in relatively few instances do the commercial aircraft produced since the armistice show evidence of real attention to commercial requirements and complete indifference to those characteristics of value only in time of war.

Even as the surplus war stock disposed of at little more than junk prices is the greatest handicap with which the industry has to contend in selling new machines, so the war's legacy to the designer has made it difficult for him to produce new airplanes which would be definitely superior to those rebuilt war machines for the purpose of commerce. He must now start his studies again from the commercial point of view.

* Taken from "The Christian Science Monitor."

Commercial Requirements.

The technical requirements of commercial aircraft may be grouped in a general way under the heads of safety, economy and comfort. Safety and economy, especially the latter, offer problems insufficiently understood as yet, especially since the requirements for economical operation and for avoidance of danger often seem to be directly contradictory.

To increase the safety of aircraft means primarily to increase the structural strength, to eliminate the risk of forced landing, to make fires in the air impossible, and to improve the stability materially over that of the airplanes now available. The subject of structural strength is one rather too technical for discussion here. Suffice it to say that structural failures can always be overcome and that the strength can be made as great as proves to be necessary. Structural problems are never insoluble.

The question of eliminating a forced landing opens more interesting possibilities. Of course, only a very small percentage of forced landings lead to any serious trouble at present. They are, however, an ever-present hazard, and in flying over desert, mountain or jungle or in flying at night, a forced landing may easily become the almost certain precursory of disaster. While statistics do not exist, it is probably safe to say that 85 per cent of the forced landings which occur at the present time are chargeable to the power plant, substantially all of the remainder being due to fog or other bad weather conditions. A forced landing due to weather, of course, is as a rule less dangerous than that arising from engine trouble, as the pilot can choose his own place and time of descent within wide limits in the first case, while he must come down at once wherever he is if the engine stops. Furthermore, of the landings resulting from engine trouble, it is probable that at least nine out of ten arise from difficulty with some one of the engine accessories, such as the fuel feed arrangements, the lubrication system, or the ignition. Only very rarely is an airplane forced to descend by breaking of a structural part of the engine itself. The problem of eliminating forced landings then becomes a problem of cutting down the failures of these accessories or of supplying them in duplicate so that the failure of a single one will not require a descent.

The reliability is being improved continually, but it is too much to hope that it will ever be perfect. There is no machine designed and built by human beings which does not break down at times. Some of them have a very perfect record, but there is none which is perfect enough to justify staking the lives of passenger and crew on its continued functioning, and there is no reason to think that the airplane engine will ever prove an exception to the rule in this respect. The only real hope of suppressing the forced landing appears then to lie in the duplication or multiplication of units performing the same function.

Duplicate Engines.

The duplication of power plants has frequently been practiced, and many of the most successful military machines produced in this country have two separate engines set out on the wings and each driving its own propeller. From the commercial standpoint, however, the use of two engines on the wings cannot be regarded as a satisfactory solution. If the use of two engines is to prove a real safeguard in case of trouble, it is necessary that the airplane be capable for a flying level with one engine completely cut off and carrying the other as a dead load. This requirement is not compatible with economy or real commercial efficiency, as the commercial airplane must have only a small margin of power under normal conditions if it is to be operated at reasonable cost. Another disadvantage of the two-engine machine with the engines on the wings is that when one engine is stopped the push of the other propeller is so far off center that it is almost impossible to hold a straight course toward a desired point, the unbalanced propeller thrust tending to swing the airplane around. We should not then expect very much from the use of two engines.

The use of three or four offers a much more attractive outlook. The design of a machine to operate with satisfactory economy and able to fly with three engines out of four is a much simpler proposition than obtaining the ability to fly with one out of two. It appears than that the airplane of the future, at least insofar as machines to be used over difficult country and for night flying are concerned, must be possessed of multiple power plants.

Improving Stability.

After the forced landing, the most prolific cause of accident in flight is instability and loss of control of one sort or another. Extensive experiment has been conducted with a view to improving stability and control of airplanes, and marvelous results have been obtained, so that it is now a commonplace for a machine to be able to fly for a considerable period without the pilot's touching the controls. The gain accomplished by mere modifications in design is so great that the development of automatic devices for the purposes of stabilizing the airplane hardly seems necessary. That, however, is a large subject worthy of separate study. The only foe that really remains to be vanquished in the realm of instability is the tail spin resulting from attempting to turn from a low altitude with insufficient power. When designers and students of aerodynamics have learned to produce airplanes incapable of spinning, there will have been accomplished the longest single step that remains to be taken on the path to complete safety.

Features of economy dictate that the airplane shall operate with a small reserve of power and accordingly at a low fuel cost. They also require that the depreciation of the structure shall be slow. The deterioration of aircraft at the present time is much more rapid than it should be, and they cannot be considered satisfactory for commercial use until the present life of the engine is at least tripled and that of the most vulnerable parts of the airplane is considerably increased. In particular, the use of fabric for covering the wings and body of commercial machines is intolerable, as it is necessary to recover wings with fabric several times before the internal structure needs to be overhauled. The development of wing coverings of light veneer and of thin sheet metal are among the most promising structural improvements that have yet appeared.

As for the engine's increased life and increased reliability, necessary both for safety and economy, they find a common solution. Both mean increased weight of the engine. It is impracticable with existing knowledge of materials to build engines weighing less than two pounds per horsepower which will give the durability and steadiness of operation necessary if the airplane is seriously to compete with other means of transport, and some useful load must be sacrificed by adding weight to the engine, bringing it up to three or possibly four pounds for every horsepower.